Quality Assurance/Quality Control (QA/QC) and Additional Deliverables for Los Angeles Region Imagery Acquisition Consortium (LAR-IAC4)

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Dewberry Tasks to be Completed

1. QA/QC Management Tasks and Update of Quality Plan
2. QA/QC of Aerial Triangulation (AT) process/reports
3. QA/QC of 4 inch pixel digital orthophotos (urban areas)
4. QA/QC of 1 ft pixel digital orthophotos (national forests)
5. QA/QC of updated breaklines/DTMs and LiDAR DTMs
6. QA/QC of oblique aerial digital images

7. Full delivery of countywide & SLDS datasets
8. Production of additional data products (re-sampled, JPEG 2000, SDE or FGDB for SLDS)
9. Mosaic generation (ECW)
10. Assistance with production management, optional items
11. QAQC of Digital Terrain Data (LiDAR Deliverables)

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Quality Plan

Acceptance Criteria for Digital Orthophotos:

- Completeness and Aesthetics
- 1’ and 4” GSD
- Aerotriangulation (AT)
- Ground Control
- Digital Surface Model
- QA/QC Checkpoints
- QA/QC of LiDAR Deliverables

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Imagery Acceptance Criteria

	Responsible Company	Tested Characteristic	Measure of Acceptability
A		**All Scales Orthoimagery**	
A.1.	Sanborn to Dewberry; then Dewberry to LAR-IAC	Media: USB External hard drives	Media is readable, all files accessible, no files corrupted
A.2.	Dewberry	Media label	As specified by LA County
A.3.	**	File organization	Files written in tile sheet order
A.4.	Sanborn	File name	Conforms to required convention- based on CA SPCS Zone 5 L4_xxxx_yyyya (a-d) for 4 inch and xxxx_yyyy for 1 foot orthos
A.5.	Sanborn	GeoTIFF format	File reads in ESRI (see sample of GeoTIFF header)
A.6.	Sanborn	Files must open in correct location	Files must open with ESRI software
A.7.	Sanborn	Pixel definition	GeoTIFF file must reference to the center of the pixel located in the upper left hand corner of the tile as the point of origin
A.8.	Sanborn	Georeferencing	For correct pixel size 0.33 ft (4 inch) and 1 ft.
A.9.	Sanborn	Vertical Datum	NAVD88
A.10.	Sanborn	Projection	NAD 1983 State Plane – California Zone V
A.11.	Sanborn	Horizontal Datum	NAD 83 reference datum
A.12.	Sanborn	Units	U.S. Survey Feet
A.13.	Sanborn	24 bit natural color	256 levels of value for each band, 0=black, 255=white
A.14	Sanborn	Conformance with tile index grid	Tile matches grid, no gaps between tiles at 1:1 view.
A.15.	Sanborn	Coverage	Full tiles; no voids. As indicated in County Data and Reference Maps. The basic rule is at least 500' buffer around LA County boundary (no partial tiles, no seams and no overlaps) with all tiles delivered being full tiles. Flying and image capture teams should be aware of this.
A.16.	Sanborn	Tile grid layout	Full tiles only with no gaps or seams between 4 inch and 1 ft. areas. Flying and image capture teams should be aware of this.
A.17.	Sanborn	Metadata	Complies with standard metadata delivered for LAR-IAC4 (to be determined by LA County). Meets minimum FGDC Content Standard.
A.18.	Pictometry	Pictometry sensor anomalies	Contractor will work to identify and correct any deficiencies caused by sensor anomalies. These include exaggeration of tall buildings and artifacts that degrade the integrity/usability of the image. Pictometry will be responsible for refights associated with sensor anomalies.
A.19.	Sanborn	Radiometry	Radiometry should be consistent throughout the imagery, on large and small scales. In general, details should be visible in shadow and in bright areas of the images and values of 0 or 255 should be minimal. < 2 percent of values at 0 or 255, to the extent possible per client's radiometry choices. Radiometry target chips (from "Prototype" areas) will be reviewed and approved by the LA County prior to orthoimagery production. The chips will provide a guide and expectation of final imagery appearance.
A.20.	Sanborn	Image Appearance	No image artifacts. Imagery should not appear speckled or pixilated when viewed at compilation scale assumed to be 1"=100' (water surfaces are exempt from this requirement with the exception that water surfaces must meet the "Governor's Test"). For example the water surface of inland bodies of water should be made more consistent so as not to cause concern regarding cleanliness or the water.
A.21.	Sanborn	Color Consistency	Colors should be consistent throughout the content of the 12 inch product and the 4 inch product. The 12 inch product will be color balanced separately from the 4 inch product. Mosaic seamlines should not produce great visual (tonal, brightness) differences in imagery on either side (water being exempt from this requirement). In some instances, greater differences may be allowed if the correction will cause significant degradation of the image content on either side. Color balancing between tiles should be as consistent as possible. No image will be rejected for radiometry inconsistencies without prior approval of LA County.
A.22.	Sanborn	Smears	Normally corrected by adding mass points or breaklines to DTM as necessary to reflect actual terrain or by image processing where appropriate. Where DTM corrections or image processing will result in reduced horizontal accuracy or misrepresentation of the location or appearance of important features (buildings, roads, etc.), the smear will remain untreated. No image will be rejected for smears without prior approval of LA County.

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Imagery Acceptance Criteria

A.23.	Sanborn	Wavy features	Distinct linear ground features (such as road markings, and curbs) should not deviate from their apparent path by more than 3 feet measured perpendicular to the feature within any 100 foot length unless correction would reduce overall product accuracy.
A.24.	Sanborn	Mosaic lines	Minimize mosaic lines through buildings. No mosaic lines through above-ground transportation structures carrying automobiles or trains unless unavoidable, as well as foot bridges crossing 2-lane roads or larger. Mosaic lines may pass through power transmission towers, cars, trucks and railroad cars.
A.25.	Sanborn	Building lean within Downtown areas (polygons provided by LA County)	Buildings shall not lean to a degree that they a) Intersect with an adjacent building. b) Obscure transportation features.
A.26.	Sanborn	Bridges (polylines provided by LA County)	For accuracy of multi-layered bridge decks identified by LA County, 3D breaklines are required to ensure continuity of deck surfaces. LA County will provide bridge locations countywide in shapefile format (polyline layer)
A.27.	Sanborn	"Governor's Test"	Imagery should not cause alarm by giving false impression that a bridge is sagging or that there are serious hazards to public safety. This includes inland waterbodies that are used as drinking or recreational sources. See page 42.
A.28.	Sanborn	Shadows	Shadows should not be of a degree that they obscure surrounding features.
A.29.	**	Leaf-off	N/A
A.30	Sanborn	Urban Canyon (polygons provided by LA County)	Specified "Downtown Areas" have been indicated via shapefile and sent to Contractor and Dewberry. Special care will be made in these areas to reduce building lean and shadows. Flying patterns may need to be adjusted for this including restricting capture times to optimal sun angles.

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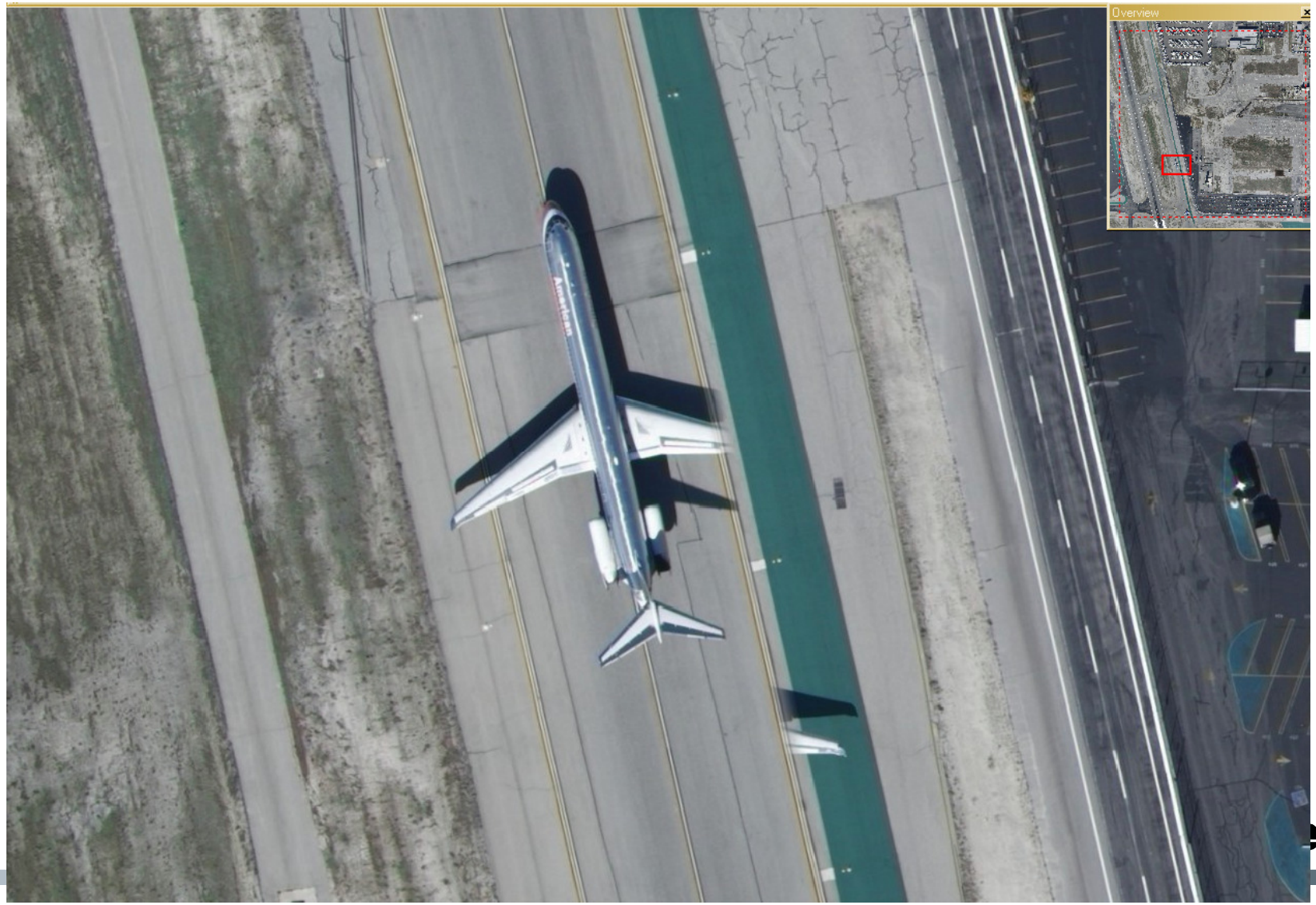
Fails “Governor’s Test”



Imagery Acceptance Criteria by GSD

Acceptance Criteria B: 1-foot GSD

B	1-foot GSD, equivalent to 1"=200'-scale (1:2400)	
B.1.	Ground Resolution	1 foot
B.2.	Tile size	5280' x 5280'
B.3.	Mismatch of features along mosaic lines and production block boundaries of equal scale	Equal to or less than 3 pixels on well defined ground features (roads, sidewalks, curbs).

Acceptance Criteria C: 4-inch GSD

C	4 inch GSD, equivalent to 1"=100'-scale (1:1200)	
C.1.	Ground Resolution	0.33 U.S. survey foot (2 decimals)
C.2.	Tile size	2640' x 2640' (8000 pixels x 8000 pixels)
C.3.	RMSE of known ground points measured on the image *See ASPRS Class I Standards Page 8, Table 16, and NSSDA Part 3, Appendices 3-A and 3-D for explanation of formulas.*	$RMSE_x = RMSE_y = 1.0$-ft $RMSE_r = 1.4142 * RMSE_x = 1.4142 * RMSE_y = 1.41$-ft
C.4.	NSSDA radial accuracy	NSSDA accuracy (20+ points) such that $1.73 * RMSE_r < 2.5'$
C.5.	Mismatch of features along mosaic lines between pixel resolution blocks of equal scale	Equal to or less than 4 pixels on well defined ground features (roads, sidewalks, curbs).
C.6.	Mismatch of features between 1-foot and 4-inch images	Equal to or less than the combination of the B.3. and C.5. criteria (4.3') on well defined ground features (roads, sidewalks, curbs).

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LAR-IAC3 Orthophoto Accuracy Testing

Criteria for 4-inch GSD Imagery	Acceptance Criteria	Tested
$RMSE_x$ (acceptance criteria 30)	1.00 ft	0.262 ft
$RMSE_y$ (acceptance criteria 30)	1.00 ft	0.341 ft
$RMSE_r$ (acceptance criteria 30)	1.41 ft	0.429 ft
$Accuracy_r$ (acceptance criteria 31)	2.50 ft	0.743 ft
Aerial Triangulation Block(s) used	N/A	27
Number of QA/QC checkpoints used	N/A	126

Tested 0.7433 feet horizontal accuracy at 95% confidence level.

David F. Maune, Ph.D., PS, GS, CP
Project Manager

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LAR-IAC3 Oblique Imagery Accuracy Testing

Table 1. Accuracy Statistics for LAR-IAC's Pictometry Imagery

Pictometry Airborne Oblique Imagery	Accuracy Statistic	North View (feet)	South View (feet)	East View (feet)	West View (feet)	Average of All Views[1] (feet)
Number of Points Visible on 133 Usable Targets		115	123	121	120	124
Horizontal Accuracy	$RMSE_x$	1.04	1.12	1.88	2.60	1.00
	$RMSE_y$	1.33	1.20	1.18	1.30	0.62
	$RMSE_r$	1.69	1.64	2.22	2.91	1.18
	$Accuracy_r$	2.92	2.84	3.85	5.03	2.04
Vertical Accuracy	$RMSE_z$	0.47	0.81	0.65	0.74	0.58
	$Accuracy_z$	0.93	1.60	1.27	1.46	1.13

[1] Average is of 4-views if the target point was visible from all four directions; average is of 3-views if the target point was visible only from three directions; average is of 2-views if the target point was visible only from two directions; a few points were visible from only one direction.

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AT Acceptance Criteria

Acceptance Criteria D: Aerotriangulation Pictometry Responsibility

D	Tested Characteristic	Measure of Acceptability
D.1.	Report Format	Conforms to required convention
D.2.	Report Completeness	All information complete and readable; reviewed and signed by a CP.
D.3.	PATB format ASCII AT files	Camera data, photo coordinates (PATB), adjusted control (ptXYZ), Orientations (ORI), and AT log files (aat.log)
D.4.	1"=100' map scale AT Horizontal accuracy against ground control	For 100' AT blocks, $RMSE_x$ and $RMSE_y$ values are acceptable up to 0.35'. $RMSE_r$ is acceptable up to 0.5'. Higher RMSE values are subject to review.
D.5.	1'=200' map scale AT Horizontal accuracy against ground control	For 200' AT blocks, $RMSE_x$ and $RMSE_y$ values are acceptable up to 0.6'. $RMSE_r$ is acceptable up to 0.84'. Higher RMSE values are subject to review.
D.6.	RMSE of control and tie points.	<10 micron in x and y. Higher RMSE values are subject to review.
D.7.	RMSE of survey check points	Not to exceed 12 micron in x and y.
D.8	NSSDA analysis [E,N] of 20+ QA points	95% within 1.73 * RMSE for corresponding scale

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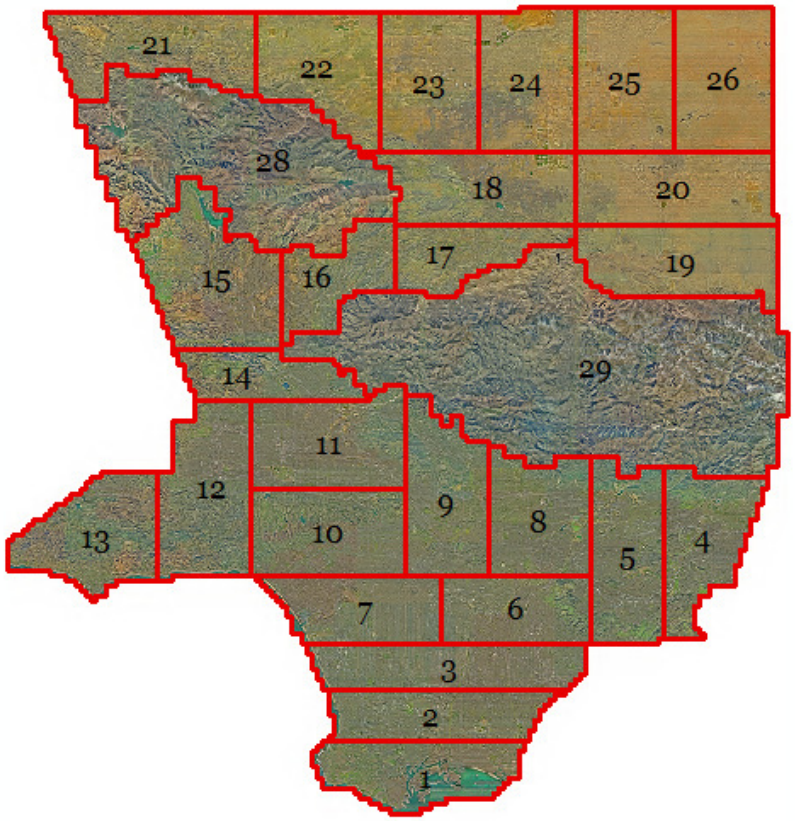
Aerial Triangulation (AT) Blocks



AT blocks must pass Dewberry's QA/QC before production of digital orthophotos can begin.

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AT Block 9, RMSE Statistics

Digital Aerial Triangulation Report Acceptance / Rejection Notification Form

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RMSE Values (Criteria D.4/D.5)

Allowable $RMSE_{x,y}$ = 0.35' *Allowable $RMSE_r$ = 0.50'*

$RMSE_x$ = 0.118' ☑ Meets Requirements ☐ Does Not Meet Requirements

$RMSE_y$ = 0.101' ☑ Meets Requirements ☐ Does Not Meet Requirements

$RMSE_r$ = 0.155' ☑ Meets Requirements ☐ Does Not Meet Requirements

```
RMS automatic points in photo (number: 3036836)
        x           1.3 micron
        y           1.4 micron

RMS   control and manual points in photo (number: 1694)
        x           2.2 micron
        y           2.2 micron
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AT Block 9 Review Analysis

This project was solved in feet. The control std devs used for 70 of the control points were 0.050 ft in XY and 0.01 ft in Z and for the remaining 41 additional points were 0.15 for XY and 0.010 ft in Z. The image measurement std dev used was 4 microns for automatic points and 2 microns for manual and control measurements.

The AGPS std devs were 0.30 ft for X and Y and then 0.5 ft for Z.

The IMU (omega, phi, kappa) std devs were 0.015, 0.015, and 0.035 degrees.

This project contained 20,386 photos across 533 strips according to the AT report.

There are a total of 3,040,021 measurements with an average of 150 measurements per photo!

There are roughly 184 photos per control point.

The sigma for the adjustment was 1.6 microns or 0.2 pixels.

There was a total of 111 control points.

There are no apparent gaps in the project.

There is one area east edge of this project where the seamlines may be a problem. This area is noted below.

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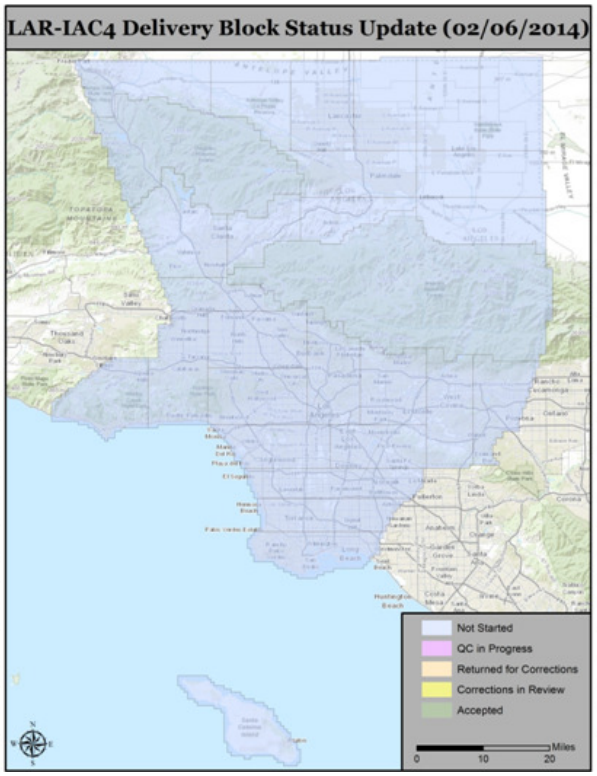
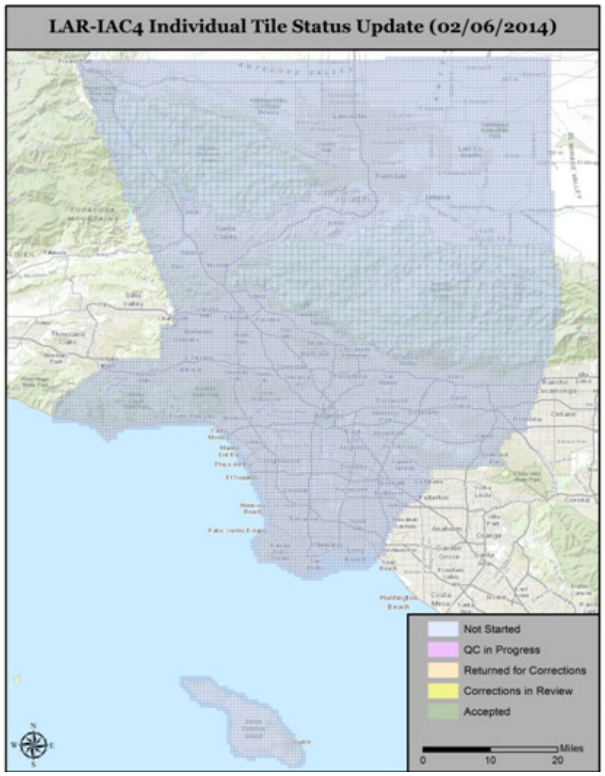
LAR-IAC4 4” Ortho QA/QC Status Maps





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Any Questions?

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